THE GROWTH AND DEVELOPMENT OF YOUNG GOLDEN MICE, *OCHROTOMYS NUTTALLI* [1]

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The golden mouse, *Ochrotomys nuttalli* (Harlan), although previously considered to be a highly divergent species in the genus *Peromyscus,* has recently been accorded separate generic status (Hooper, 1958). A number of references to the taxonomy, distribution, ecology, and habits of the golden mouse have appeared in the literature, but there have been few comprehensive studies of the biology of this interesting, semiarboreal rodent. Goodpaster and Hoffmeister (1954) have given a general account of the life history of the golden mouse in Kentucky, and Pearson (1953) and McCarley (1958, 1959) have dealt with certain phases of its population ecology in Florida and Texas. Although Goodpaster and Hoffmeister (1954) give information on the growth and development of the young, this aspect of the life history of the golden mouse is as yet inadequately known. The present paper provides further details of the physical and behavioral development of the young together with data on the breeding season and litter sizes of the species in Florida.

Materials and Methods

Observations have been made on 11 young of 5 litters born in captivity to females trapped in the vicinity of Gainesville, Alachua County. The growth and development of 4 litters (8 young) born in July, 1959, were followed in detail. The remaining litter was born to a female captured in January, 1960. This animal was found in a weakened condition in the trap the day before parturition. The young did not appear to be normally developed at birth, and their subsequent growth and development were considerably retarded in comparison with the other litters. Consequently, the data from this litter have not been utilized in the following account.

The females gave birth to their young within 1 to 5 days after capture, the births occurring during the following maximum time intervals: 3 p.m.-9 a.m., 10 a.m.-12 noon, 4-8:30 p.m., 10 a.m.-5:30

[1] A contribution from the Department of Biology and Florida State Museum.

p.m., and 6:30-9 a.m. Some indication of the magnitude of weight gain prior to parturition is provided by one female that gave birth to 2 young 5 days after capture. This animal weighed 20.0 grams when trapped, 26.8 grams 3 days before birth, and 27.9 grams on the day before partum. Another female weighed 24.2 grams on the day preceding the birth of a litter of 2.

Sex was positively determined for 8 of the 11 young; these consisted of 5 males and 3 females.

The young of all litters were weighed on the day of birth, as soon after being discovered in the nest as possible, and measurements were recorded for all surviving young of the 4 litters studied in detail at each week of age from 1 through 8 weeks and at 35 weeks. Measurements were taken on anesthetized young and included total length, tail length, hind foot length, and ear length from notch. Body length was determined by subtracting tail length from total length. Instantaneous relative and percentage growth rates were calculated according to the method of Brody (1945).

The young proved to be highly sensitive to ether anesthesia, and, though considerable care was taken to remove them from the ether jar prior to cessation of activity, over half of the young were lost through failure to recover from etherization. Because of the danger of over-anesthetizing the mice, it was not always possible to obtain a fully relaxed individual for measuring. Thus slight discrepancies in the measurements of the same individual from one week to another are occasionally evident in the data. Adult golden mice exhibited the same low tolerance to ether as the young. Svihla (1932) has noted a marked difference in the reaction to ether of *Peromyscus maniculatus* and *P. leucopus,* the latter apparently resembling the golden mouse in its sensitivity to the anesthetic.

Breeding Season and Litter Size

Goodpaster and Hoffmeister (1954) recorded pregnancies in golden mice in March, April, July, and October. McCarley (1958) stated that breeding in eastern Texas apparently commences in September and extends through the cooler months of the year. There are few data on the breeding season of the golden mouse in Florida. The 5 births recorded here occurred on July 10, 28,

29, 30 and January 27. In addition, 3 pregnant golden mice and a lactating individual have been trapped in July, 2 gravid specimens have been collected in September and November, and a female with newborn young has been captured in a nest on March 12. Barrington (1949) and Ivey (1949) also record pregnancies in September and November, and the latter notes finding nest young of estimated ages of 1½ months and 1 week in November and December, respectively. I have taken juveniles ranging from approximately 3 to 8 weeks of age in January, March, and September.

Goodpaster and Hoffmeister (1954) indicate a gestation period of 29 or 30 days for the golden mouse, apparently on the basis of a single female that was nursing a litter during at least a portion of the pregnancy. Presumably, then, gestation in this species may normally be somewhat shorter. However, allowing approximately a month for gestation and back-dating to the approximate date of conception in the above cases a total of 18 estimated breeding dates is distributed as follows: June or July—5; August—4; October—1; November—5; December—1; and late January or early February—2. These limited data suggest that the breeding season of the golden mouse in Florida extends over at least an 8-month interval, with peaks possibly occurring in early summer and the fall.

Four of the litters born in captivity consisted of 2 young, and one had 3. These plus other counts of embryos or nest young available, including data given by Barrington (1949) and Ivey (1949), provide 11 records of *Ochrotomys* litters in Florida. These include six cases of 2 embryos, three instances of 3 embryos or nest young, and one case each of 4 and 5 embryos, giving a modal number of 2 and a mean of 2.7 young per litter. On the basis of this small series it appears that the litter size of the golden mouse in Florida does not differ significantly from that observed in Kentucky and Texas populations (Goodpaster and Hoffmeister, 1954; McCarley, 1958).

PHYSICAL DEVELOPMENT

Pelage. Young examined within 3 or 4 hours of birth (Fig. 1,A) were reddish in color, with a slightly grayish cast to the dorsum. The skin was relatively smooth, and blood vessels were prominent, particularly on the lower sides and limbs. The cranial sutures of the skull were evident, and the viscera were visible through the skin of the abdomen. The pinnae, which were somewhat lighter

in color than the remainder of the dorsum, were folded over and sealed. The dark iris and pinkish lens of the eye were visible through the sealed lids, and the line of fusion of the latter was evidenced as a slight furrow. The mystacial vibrissal pads were swollen, and the vibrissae themselves were well developed. The longest of the series extended backward to the anterior margin of the eye. Short bristles were fairly numerous on the lips and chin, and widely scattered, longer, light colored hairs were present on the dorsum. Dark pigment specks marking hair follicles were visible in the skin of the dorsum as well. The tail was not noticeably bicolored and lacked hairs.

When approximately 12 hours old, the young had more fine hairs on the dorsum than at birth, and stouter dark hairs were just beginning to appear on the top of the head.

The skin of the young at 1 day of age appeared drier and more rugose than at birth, and the dorsum was decidedly more dusky. The viscera were still faintly visible through the skin of the abdomen. The density of the light hairs on the upper part of the body had increased, and a few widely scattered ones were now present on the lower sides and on the limbs above the ankles and wrists. Dark hairs were visible on the crown, nape, and shoulders. The tail was still hairless but had assumed a faint bicolor pattern due to developing pigmentation on the dorsal surface. A dark patch was evident on the ankles, although no hairs had yet appeared, and a few dark pigment streaks were also present on the carpus.

By the 2nd day of age the dorsum of the young had darkened further, and the ventral parts were somewhat lighter in color. The skin was more opaque and had taken on a scale-like pattern. Longer hairs were abundant over the dorsum and were more obvious, although still quite sparse, on the venter. The dark hairs on the dorsum had extended to the lower rump. The ankle patch was more prominent and contained a few hairs. Scattered dark hairs were also now visible on the wrists. Short hairs had extended about half way out on the forefeet but did not reach much beyond the ankles on the hind feet. The hairs just posterior to the ears and those on the rump were the longest on the body. The pinnae showed faint pigmentation on the anterior portion but no hairs were yet visible. The skin on the tail was still smooth, and in most individuals the outline of hairs could be seen beneath the surface

on the dorsal aspect, although in only one young had they actually begun to erupt by the 2nd day. Teats were faintly evident in females.

In 3-day-old young the dorsal skull sutures were no longer visible, and the pelage was sufficiently developed on the upper parts to produce a slightly fuzzy appearance. The head exhibited a faint reddish-brown coloration, in contrast to the gray of the rest of the body. The dark hairs on the back extended to the base of the tail but remained densest anteriorly. A few dandruff-like flakes of epidermis were visible on the backs of some specimens at this age. Numerous dark hairs were growing on the ankles; those on the wrists were fewer. No hairs were yet noted on the digits or pinnae. A scale pattern was evident on the tail, and short hairs had appeared.

On the following day the reddish-brown coloration of the head was more apparent, and a tinge of similar color had appeared on the nape. The long dorsal hairs were distinctly visible to the naked eye, and the ventral pelage was much thicker, though still more sparse than that on the upper parts. Short hairs were now present on the digits, a coating of fine hair had appeared on the lateral surfaces of the pinnae, and hairing of the tail was more distinct. Scurfy epidermal scales were more abundant than on the previous day.

At 5 days of age (Fig. 1, B) the young were more or less reddish-brown over the entire dorsum, although brightest on the head and shoulders. The digits were well haired. The iris of the eye was no longer visible, and the lids were covered with a fairly dense growth of hair. The crease marking the line of fusion of the lids was by now heavily pigmented and quite distinct.

The pelage had taken on a sleek, velvety sheen by the end of the 1st week, (Fig. 1, C) and the young were now easily recognizable as golden mice. Fewer epidermal scales were present on the dorsum at 7 days than at 6.

At 8 days of age no epidermal scales were visible on the back, although they were still numerous on the ventral surface. The eyelids were fully haired, only the pigmented edges being glabrous. The hairs on the pinnae were visible to the eye. By the following day the number of epidermal scales on the belly had diminished, and the hair on the ventral parts was noticeably thicker. By the

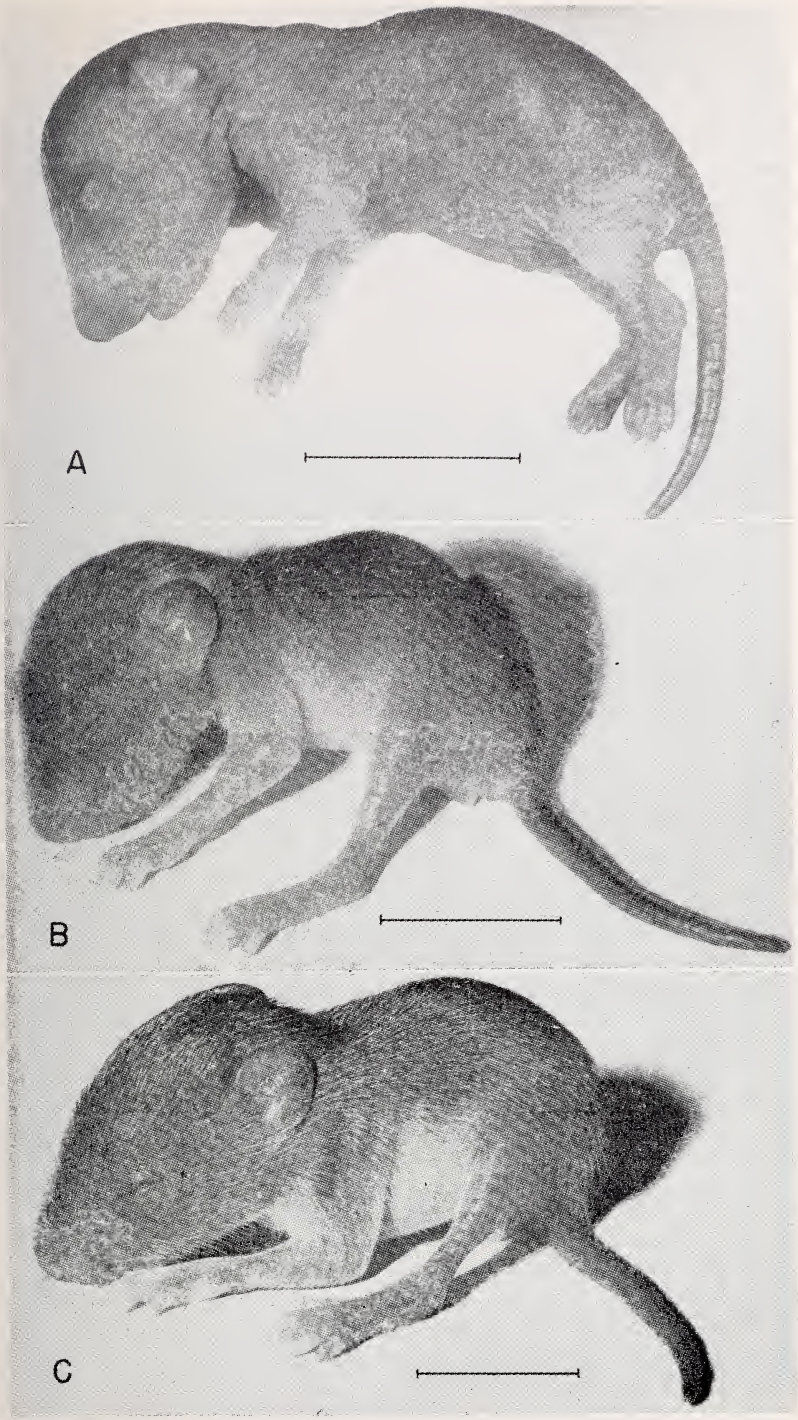

Fig. 1. Stages in the development of the golden mouse, *Ochrotomys nuttalli.* A. Newborn young, B. Five days of age, C. One week of age. Scale in each case equals approximately 1 cm.

10th day (Fig. 2, A) the epidermal scales had disappeared entirely, and the dusky ankle and wrist patches were less obvious than before. At this age the pinnae began to assume a reddish tinge due to the growth of the hair covering them. By the end of the second week the juvenile pelage, which was decidedly duller than that of the adult, appeared to be fully developed, except possibly for some subsequent increase in the length of the hairs.

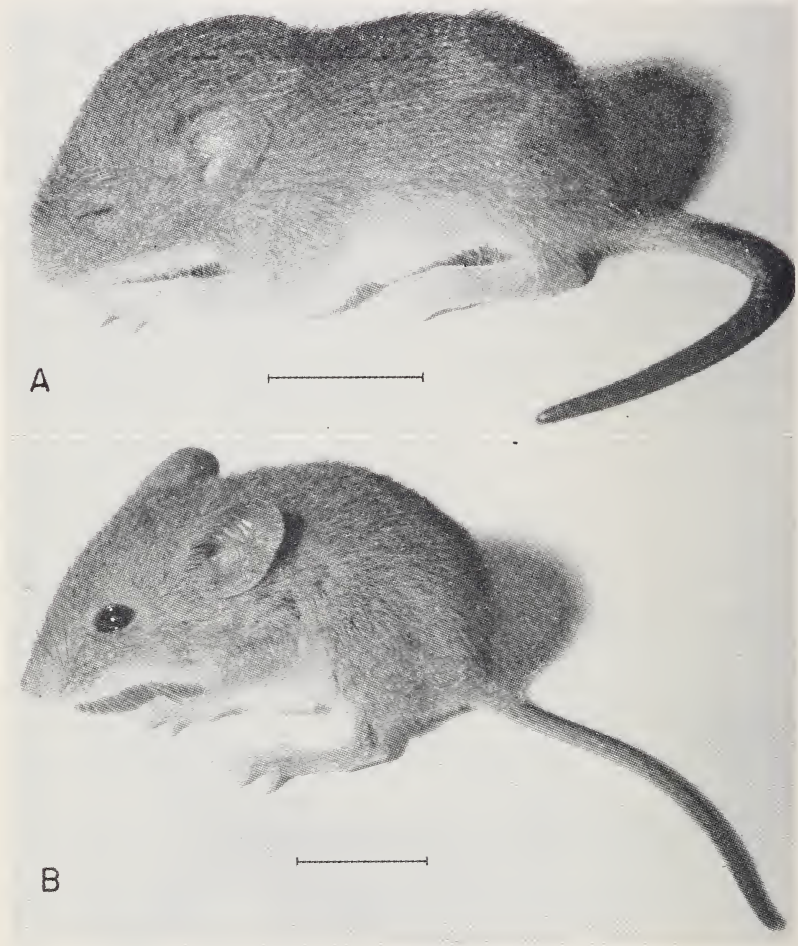

Fig. 2. Stages in the development of the golden mouse. A. Ten days of age, B. Three weeks of age. Scale in each case equals approximately 1 cm.

The post-juvenile molt apparently commences about the 4th or 5th week. One young was molting at 31 days of age, and the molt was apparently complete 10 days later. It appeared that the pelage on the venter was replaced first and that the molt of the upper parts progressed generally from the lower sides dorsally, spreading anteriorly and posteriorly in the process. A buffy wash appeared on the venter of this individual during the later stages of the molt. A second specimen was molting at 4 weeks of age, while another accidentally killed at the same age had not yet begun to molt.

Few data are available on the chronology and pattern of adult molts in this species. Of 56 study skins of adults from Georgia and Florida examined in the University of Florida mammal collection, only five exhibit molt. Three of these were collected in October and one each in March and June.

Claws, ears, and eyes. The digits were not separated at birth, and the claws were small, soft, conical structures. The claws appeared sharper during the 1st day of age and by the 2nd were more curved and opaque. The digits were well separated and the claws were nearly of definitive shape by the 5th day of age.

The pinnae unfolded in most of the young on the day following birth, although in one individual the ears did not unfold until the 2nd day. In some individuals the pinnae were still bent over or projecting out to the sides on the 1st day and did not lie flat against the head until the 2nd day. The external auditory meatus was distinctly open and the young exhibited a definite reaction to a sharp squeak at 8 days of age in one litter, 9 days in another, and 10 days in a third. In each case the external orifice of the ear appeared to be patent a day earlier than that on which a reaction to sound was actually elicited.

The eyes of two litters opened on the 11th day of age and those of a third litter on the 12th day. Golden mouse young studied by Goodpaster and Hoffmeister (1954) opened their eyes between the 11th and 15th days, the average being 12.8 days.

Dentition. The incisors were visible just below the surface of the gums by the 3rd or 4th day of age. In one litter the teeth were just perforating the gums on the 4th day and were well above the gum line on the following day. In another litter the incisors erupted on the 6th day. When the incisors first appeared above the gum

tissues they were chalky at the bases and rather translucent at the tips. The lowers were about twice the length of the uppers, and this approximate proportion persisted during subsequent growth of the teeth.

The lower incisors were about 1 mm. long and the uppers, 0.5 mm., in one young at 11 days of age. On the 13th day the lower incisors had increased to approximately 1.5 mm., and were faintly yellowish at the base. At 2 weeks the lowers were about 3 mm., and the uppers somewhat over 1 mm. By the 3rd week both pairs of incisors had taken on a distinctly yellowish cast. The cheek teeth were fully developed in specimens killed at 4 and 5 weeks of age.

Weaning. The young are apparently weaned at about 3 weeks of age (Fig. 2, B) or slightly earlier. Young of all litters were found nursing when uncovered in the nest for examination at 2 weeks of age but not at 3, when they were first seen out of the nest at night. The stomach of a young killed at 4 weeks of age contained only solid food.

BEHAVIOR OF THE YOUNG

The young of the golden mouse appeared to be strong and well coordinated at birth. They could cling to a finger without falling off when the latter was held at about a 45 degree angle and if upset would twist and roll about until they regained an upright position. They were also seen to lift the front half of the body clear of the ground by thrusting upwards with the fore legs. The newly born mice gave a rasping squeak that seemed particularly loud and insistent.

At 1 day of age the young could take a few shaky steps, dragging the venter on the substrate. They also seemed able to right themselves more easily than at birth and were better able to cling to an inclined hand, always orienting with the head directed upwards.

Two-day-old young attempted to maintain an upright posture and resisted being pushed over. The prehensile nature of the tail was already evident. The young golden mice were only rarely observed to give convulsive twitches when lying undisturbed in a nest or cloth-lined dish. This behavior was not noted after the 3rd day of age. Young at 2 days of age were heard to give two kinds of sounds: a high-pitched thin squeak and a lower-pitched grating note.

The young were noticeably stronger at 3 days of age. They exhibited a rapid righting response when pushed over and could cling to a finger held vertically by more or less wrapping their body around it. This precocious tendency to cling to objects might be considered as an arboreal adaptation in this species. Another behavioral trait appearing at this age that might also be associated with the semiarboreal habits of the golden mouse was a tendency for the young to remain quietly in one spot.

The young were more active when 4 days of age. They could scramble up the fingers and hang on upside down if the hand was turned over. They exhibited a good sense of balance and made obvious use of the semiprehensile tail in moving about. When together they tended to burrow beneath one another. They generally rested on the venter with the feet splayed out and gave a clear startle reaction when the tail was touched.

Five-day-old young could crawl from a flat surface into the hand and could cling to a vertical ¼-inch hardware cloth screen. At 6 days they could stand and walk with the venter off the substrate, but still exhibited no tendency to move from wherever they were placed.

By the end of the 1st week, the tendency of the mice to remain motionless where placed was quite obvious. Mice of other species of generally similar size and developmental rate tend to scramble about a bit at this age, particularly if placed on an unfavorable surface such as a cold balance pan. In a similar situation, the golden mice, in contrast, merely drew their legs beneath them and remained motionless.

By the 8th day of age the young began to exhibit some resistance to being handled. When in the hand they were noticeably "clingy" and hard to put down, sometimes hanging from a finger by one foot. Ten-day old young would begin to climb up on a finger if proded and, once in the hand, would climb upwards when the latter was inclined. At 12 or 13 days some of the young were noticeably more jumpy than earlier, often leaping from the hand when being removed from the nest. They could walk with good coordination by the 13th day and exhibited the same deliberateness in their movements as the adults. They still exhibited a tendency to huddle together. At 14 days of age the young were first seen to wash, following etherization.

The young were more active at 17 days of age and struggled more when picked up. However, when in the hand they tended to sit very quietly and allowed themselves to be stroked. They were capable of running quite rapidly, but still exhibited a strong predilection to remain motionless. When disturbed they cocked the ears forward as do the adults under similar circumstances. This "anxiety" pose was not noted earlier. One 17-day-old young was seen to wash quickly after being returned to the cage following examination. It confined the grooming actions to the head only. When another young of the same age was returned to the cage, it explored about before entering the nest, which it seemed to recognize. Its movements while outside the nest were slow and deliberate.

After the 3rd week the young began to spend more time outside of the nest at night. If surprised outside the nest when the light was turned on in the laboratory, they often remained motionless and could be easily caught. Young and adults also exhibit this sort of behavior in the field and can sometimes be caught by hand. When the young were frightened into motion, they usually attempted to climb the first object encountered. By about 5 weeks of age the only young remaining alive had become quite wild and difficult to capture. The same tendency toward increasing wildness after a period in captivity has been noted in the case of adults as well.

PARENTAL CARE

Female golden mice were usually docile when the young were being taken from the nest for examination, often remaining quietly in the nest and offering no resistance even when a young one was being removed from the teat. None of the females ever exhibited any tendency toward active defense of the young. If the female left the nest when disturbed, she generally moved out deliberately, sometimes giving the tail shake seen in *Peromyscus* and other rodents, and took refuge in a particular corner of the cage. There she would often assume a hunched-over pose with the ears laid forward in the "anxiety" position. Females were ordinarily rather slow to return to their young.

Often the mother would leave the nest with a young clinging to a teat. Since the females moved slowly, the young golden mice were seldom subjected to the rough treatment often received by

the young of other rodents when the parent dashes precipitously from the nest dragging her litter along. Goodpaster and Hoffmeister (1954) have previously commented on this point, and the more or less deliberate movements of golden mice with or without litters may have some correlation with the fact that they spend much time climbing and moving about above ground. Day-old young always dropped off the teat before the female left the nest or were free when the examination was made. At 2 and 3 days of age some young clung tenaciously to the teat, others held on when the mother left the nest but could be removed with little difficulty, and some fell off after being transported only a few inches away from the nest. There seemed to be a general tendency for the young to cling more firmly to the nipple after 3 or 4 days of age, although there was still variation in their behavior in this connection. On several occasions older young held onto the teat as the mother climbed about the sides of the cage. One 12-day-old young observed clinging to the teat actually walked behind the mother as she moved along slowly. This was the oldest young recorded as being attached to a teat outside the nest.

Females were observed to carry young on two occasions. Once the mother was seen to remove the nursing young by licking the area about the nipple and then manipulate the baby with both hind and fore feet into the mouth. She grasped the young from the dorsal side at a point just behind the nape and carried it about the cage, finally depositing it in a corner where she proceeded to wash it. Another time a mother was briefly observed carrying a young by the back. Goodpaster and Hoffmeister (1954) stated that the young observed during their study were always held from the stomach side when being transported by the mother.

GROWTH

Individual weights and measurements of young golden mice from birth through 8 weeks of age are given in Table 1. These data, using means where more than one value is available for a given age, are plotted on a semilogarithmic scale in Figures 3 (weight) and 4 (linear measurements). Instantaneous relative growth rates are given above weekly segments of each plot, and several significant developmental events are indicated along the age axis.

The mean weight and measurements of newborn golden mice expressed as percentages of corresponding adult means (based on a series of 18 specimens from north-central Florida) are as follows (adult means in parentheses): weight, 13.2 (18.3 grams); total length, 32.6 (163.5 mm.); body length, 44.2 (88.3 mm.); tail length, 19.5 (75.2 mm.); and hind foot, 39.7 (18.4 mm.).

TABLE 1

WEIGHTS AND MEASUREMENTS OF GOLDEN MICE FROM BIRTH THROUGH 8 WEEKS OF AGE

Age	Litter Number	Weight, in grams	Measurements, in millimeters			
			Total Length	Tail Length	Hind Foot	Ear*
Birth	1	2.4,2.6	50	14	7.5	——
	2	2.4,2.6	57	15	7.5	——
	3	2.4,2.6	—	—	—	——
	4	2.0,2.4	54	15	7.0	——
1 week	1	3.7,4.0	74,72	25,25	11.0,11.5	6.0,6.0
	2	4.1	75	26	11.0	6.0
	4	4.2	70	30	11.5	6.0
2 weeks	1	6.0,6.0	97,102	41,40	15.5,16.0	9.5,9.5
	2	7.1	105	45	16.0	10.0
	4	6.0	108	49	16.0	9.0
3 weeks	1	9.1,9.2	120,123	51,55	18.0,17.5	13,13.5
	2	10.9	129	60	18	12.5
	4	8.8	130	64	18	12
4 weeks	1	11.9,12.9	132,130	56,60	19,19.5	17,16.5
	2	13.8	146	70	18.5	14
	4	11.5	144	72	18.5	14.5
5 weeks	1	13.8	147	67	19	16
6 weeks	1	15.9	151	69	19	15
7 weeks	1	16.7	150	70	18.5	16
8 weeks	1	18.0	156	71	18.5	17

* From notch.

Weight exhibited a higher instantaneous percentage growth rate, 12.6 percent per day, in the week following birth than any linear measurement. The relative gain in weight declined sharply the 2nd week and then more gradually to the 5th, when a pronounced break in the curve occurred. The weight of one specimen at 5 weeks was approximately 88 percent of the mean adult

weight. At 8 weeks of age this individual weighed only 0.3 grams less than the average for adults and by the 35th week exceeded the latter by 3.6 grams.

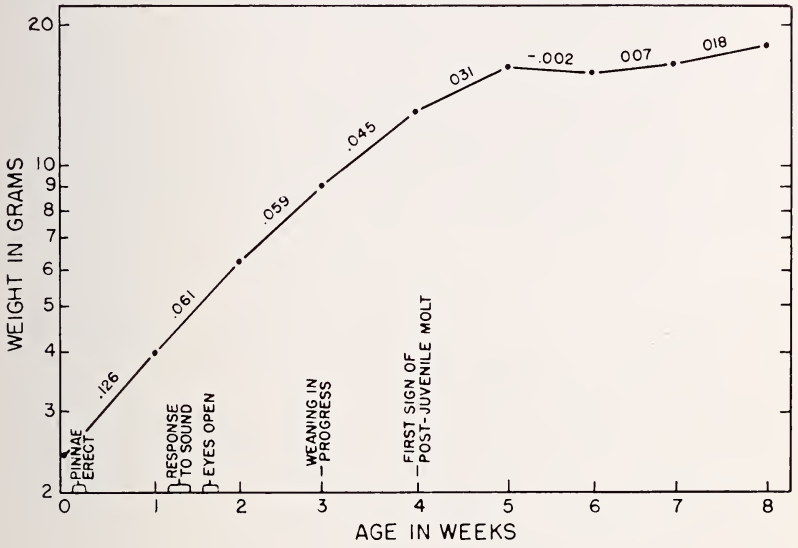

Fig. 3. Semilogarithmic plot of growth in weight of *Ochrotomys nuttalli* from birth through 8 weeks of age. Instantaneous relative growth rates are shown above weekly segments of the plot.

The tail had the highest relative growth rate of any linear dimension over the interval from birth to 3 weeks of age, at which time it had reached about 76 percent of adult size. The tail was about 93 percent of mean adult length by the 5th week and had increased to only approximately 94 percent by the 8th week of age. The tail of one specimen was 71 mm. long at 8 weeks and 75 mm. at 35 weeks.

Relative growth in total length was greater than that of body length because of the contribution of the rapidly growing tail. At 3 weeks of age total length was about 77 percent of the adult mean, and it increased to about 91 percent by the 5th week. A rather marked decline in the relative increase of total length occurred subsequent to the 3rd week. Instantaneous percentage growth rates for total length fell below the 1 percent per day level after the 5th week.

Body length showed the lowest relative growth rates of any linear measurement. A major break in the curve for this measurement occurred at 3 weeks, when body length was about 77 percent of the adult average. By the 5th week of age body length was approximately 90 percent of the adult mean, and instantaneous percentage growth rates were below 1 percent per day in subsequent weekly intervals. A specimen with a body length of 156 mm. at the 8th week of age showed an increase of 7 mm. by the 35th week. Body length, like total length, exhibited a slightly higher instantaneous relative growth rate during the 2nd postnatal week than the 1st. The reason for this is not evident.

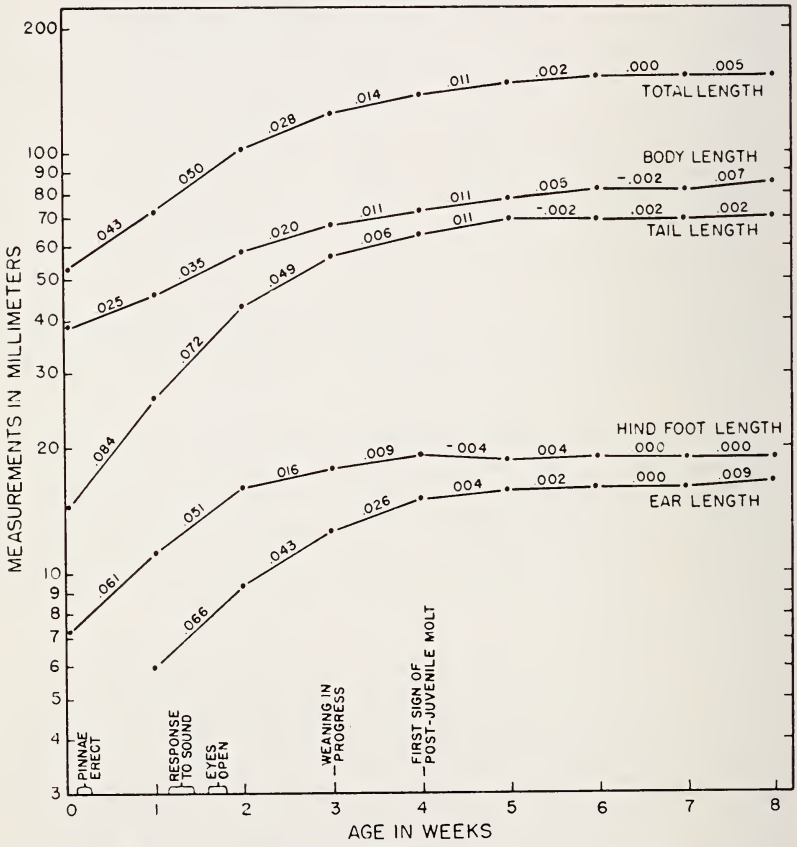

Fig. 4. Semilogarithmic plot of linear growth data for *Ochrotomys nuttalli* from birth through 8 weeks of age. Instantaneous relative growth rates are shown above weekly segments of each plot.

The hind foot grew rapidly during the first 2 weeks, at the end of which it had attained about 87 percent of adult size. By the following week, the hind foot was approximately 97 percent of mean adult length, and, allowing for slight errors in measurements of anesthetized young, it showed no further growth after 4 weeks of age.

The pinna was first measured at 1 week of age. Relative growth of this structure was higher than other linear measurements except tail length until the 3rd week and exceeded that of the tail over the 3 to 4 week interval. The ear averaged the same size as the adult by the 4th week, and in one individual showed no growth between the 8th and 35th week of age.

The noticeable decline in instantaneous relative growth rates, approximately 50 percent or less than the previous week's rate, evident at 3 weeks in the case of total length, body length, and tail length is correlated with the period of weaning. The increase in these measurements as well as in weight in a specimen at 35 weeks of age as compared to 8 weeks is probably indicative of continued slow growth in this species for a relatively prolonged period. In this connection, Dice and Bradley (1942) found that, except in the case of the hind foot, *Peromyscus maniculatus* continues to grow slowly until 6 months of age or older.

DISCUSSION

Information on various aspects of growth and development of several species of *Peromyscus,* including *P. californicus, eremicus, gossypinus, leucopus, maniculatus, polionotus,* and *truei,* has been given by several authors (Collins, 1923; Gottschang, 1956; Hoffmeister, 1951; King, 1958; Laffoday, 1957; McCabe and Blanchard, 1950; Nicholson, 1941; Pournelle, 1952; Rand and Host, 1942; Seton, 1920; and Svihla, 1932, 1934, 1935, 1936). These data, although not complete in all cases, permit at least a gross comparison of developmental and growth rates of the semiarboreal *Ochrotomys* with those of a group of species of varying sizes and diverse habits of an allied genus of rodents.

The erection of a pinnae is one of the well marked early developmental events. This occurred on the 1st or 2nd day in the golden mouse litters studied, whereas in *P. maniculatus* (several subspecies) the ears do not become erect until the 2nd to 4th days. The ages

at which erection of the pinnae has been reported in other species of *Peromyscus* vary from 3 to 5 days in *P. polionotus,* 3 to 6 days in *P. truei,* and usually at 4 days in *P. gossypinus.*

Although the time of eruption of the incisors is difficult to determine with accuracy, the available data suggest that the incisor teeth appear at a relatively early age in *Ochrotomys.* The average age at eruption of the incisors is 5.2 and 5.7 days in two subspecies of *P. maniculatus.* In *P. gossypinus* and *P. polionotus* the incisors make their appearance at from 5 to 7 days and on the 6th or 7th day, respectively. In the golden mouse, however, the incisors appeared as early as the 4th day.

The average ages at which the eyes of various subspecies of *P. maniculatus* open range from 12.1 to 16.8 days, with about 14 or 15 days being the usual age. In other species of *Peromyscus,* the eyes have been reported as opening generally on the 14th day (13-16) in *P. polionotus,* about the 13th day (10-15) in *P. leucopus,* usually from the 12th to the 14th in *P. gossypinus,* on the 13th or 14th in *P. californicus,* and from the 15th to 17th and 15th to 20th in *P. eremicus* and *truei,* respectively. The mean age at which the eyes open in the golden mouse, combining the data of Goodpaster and Hoffmeister (1954) and the present study, is 12.4 days (11-15). Thus, this developmental stage appears to occur at a relatively early age in *Ochrotomys.*

On the basis of observations on only two individuals, the post-juvenile molt in the golden mouse may commence at about the same age as in *P. maniculatus gambeli* and perhaps somewhat earlier, on the average, than in *P. leucopus, gossypinus, polionotus, truei,* and *californicus.*

Although fewer data are available on the behavioral and neuromotor development of species of *Peromyscus* and such information obtained by different workers is somewhat difficult to interpret on a comparative basis, it seems that *Ochrotomys* is behaviorally precocious as well as physically so. One gains the impression from observation and the literature that golden mice are quite strong and well coordinated at birth as compared to various species of *Peromyscus.* In the present study, young golden mice exhibited a rapid righting response at 3 days of age, whereas the average age of appearance of an immediate righting response in two subspecies of *P. maniculatus* studied by King (1958) was 7.2 and 8.9 days.

Ochrotomys young could also stand and scramble about before a week old, whereas, with the exception of *P. californicus,* the species of *Peromyscus* that have been studied in this regard (*P. polionotus, leucopus, maniculatus,* and *truei*) apparently do not exhibit equivalent locomotor advancement until the 2nd week of age.

Perhaps further evidence of relatively rapid neuromuscular maturation in *Ochrotomys* is the low frequency of involuntary twitching observed and the disappearance of this condition at about 3 days of age. In contrast, *Peromyscus floridanus* still exhibits such spasmodic twitching at 2 weeks of age (unpublished data).

Mean birth weights of *P. polionotus, leucopus,* and various subspecies of *P. maniculatus* are appreciably less than that of the golden mouse. The mean weight of newborn *Ochrotomys* compares rather closely with those of *P. gossypinus, truei,* and *eremicus,* and is greatly exceeded only by the young of the much larger *P. californicus. Ochrotomys* neonates agree with those of the larger species of *Peromyscus* in being relatively, as well as absolutely, larger.

In a detailed analysis of growth of *P. maniculatus* (subspecies *gambeli*), *truei,* and *californicus,* McCabe and Blanchard (1950) indicate that the relative growth rate for weight during the 1st week after birth becomes less with increasing species size, going from .1687 for *P. maniculatus* to .1006 for *P. californicus.* Although more nearly equivalent to the former in size and weight, the golden mouse shows a relative growth rate (.125) for the 1st week that is more in agreement with the larger species.

Subsequent instantaneous growth rates for *Ochrotomys* approximate or only slightly exceed those of the species of *Peromyscus* through 5 weeks and then fall sharply below. Half adult weight, and apparently full adult size, is attained at an earlier age in *Ochrotomys* than in the three *Peromyscus* species.

Another point of difference in the weight curves presently available for *Ochrotomys* and the *Peromyscus* species is the absence of a break in decrease in rate coincident with the period of weaning. This break in the curve, which is most pronounced in *P. maniculatus,* less so in *truei,* and least in *californicus,* is suggested by McCabe and Blanchard as being the result of a relatively decreasing milk supply followed by exploitation of new food resources following weaning. In the golden mouse instantaneous relative growth rates decline in a more regular fashion over the period of weaning.

Postnatal linear growth in *Ochrotomys* in comparison with species of *Peromyscus* studied seemingly exhibits the same general trends as growth in weight, instantaneous relative growth rates for particular measurements being generally comparable at early ages but achievement of full growth apparently being advanced in time as the result of relatively greater size at birth and the compounding of this difference during subsequent growth phases.

Although the data available for the golden mouse are limited, the foregoing comparisons indicate that it develops at a relatively more rapid rate than a number of *Peromyscus* species of comparable and larger size. This accelerated postnatal growth rate is correlated with a relatively long gestation period and the absolutely and proportionately large size of the young at birth. McCabe and Blanchard (1950) related differences in relative size and development at birth of three species of *Peromyscus* to the occurrence of birth at different points along a total growth curve from conception to maturity.

The relatively rapid development and growth of the golden mouse would appear to have adaptive significance from the standpoint of its habits and ecology, since an accelerated ontogeny would seem to be of distinct advantage to a semiarboreal species whose young are often produced in relatively exposed and accessible tree nests. The generally rapid development not only reduces the length of time the young must remain confined in the nest but also insures that important structures such as tail and hind foot are well developed and fully functional at the time when the young begin to make excursions from the nest. Particular behavorial characteristics appearing during the development of the young and which may be assumed to represent arboreal specializations in this species are the tendencies to cling tenaciously at a relatively early age, to respond to disturbance by remaining immobile, and, when sufficiently disturbed, to seek escape by climbing. The freezing response is also characteristic of the adult behavior pattern, and, although sometimes attributed to fear, it might actually function as a protective mechanism. It appears that the golden mouse is not adapted for rapid movement above ground and ordinarily proceeds with deliberateness. Thus, the tendency to freeze when alarmed rather than attempting precipitous flight may have survival value for the species. The tendency of the young not to

move around actively may also serve to reduce the likelihood of falling from the nest.

Foster (1959) has pointed out that slow and deliberate movements are also characteristic of *Peromyscus maniculatus gracilis,* a form which is semiarboreal though less strongly so than the golden mouse, and has also assumed that this pattern of movements is an adaptation for semiarboreal activity. She has also postulated that the greater tendency to freeze in a grassland subspecies, *P. m. bairdii,* is also adaptive in nature. The similar interpretation for the freezing response in the golden mouse suggests that the same behavioral characteristic in two taxa of widely divergent ecologies and habits may be equally adaptive under markedly different environmental conditions.

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Summary

Breeding records available for the golden mouse in Florida extend over an 8-month period, and mean litter size based on a total of 11 litters is 2.7.

The development and growth of 8 captive-born young are described. Young at birth had well developed vibrissae and scattered hairs on the dorsum. The full juvenile pelage was nearly developed by 2 weeks of age, and the post-juvenile molt began at about the 4th week of age in one young. The pinnae became erect on the 1st or 2nd day, the incisors erupted between the 4th and 6th days, and the eyes opened on the 11th or 12th day. The young are apparently weaned at about 3 weeks of age or slightly before.

Newly born young were relatively well coordinated. They attempted to walk when 1 day old and by 3 days of age exhibited a well developed righting response.

Mean weight and measurements at birth were: weight, 2.4 grams; total length, 53.7 mm.; body length, 39.0 mm.; tail length, 14.7 mm.;

and hind foot length, 7.3 mm. Instantaneous percentage growth rates for weight, total length, body length, and tail length dropped below 1 percent per day after 5 weeks of age, at which time the young were about 88 percent of mean adult weight and 91, 90, and 93 percent of the adult averages for total, body and tail length, respectively. Relative growth of the hind foot and ear dropped below 1 percent per day after 3 and 4 weeks of age, respectively.

Compared to 7 species of *Peromyscus* for which data are available, the golden mouse appears to be precocious in its growth and development. It is suggested that this relatively accelerated ontogeny and certain specific behavioral patterns observed are adaptively correlated with the semiarboreal habits of the species.

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